**HALOCARBON PRODUCTS CORPORATION - USE OF METHYLENE CHLORIDE AS HEAT TRANSFER FLUID OCCUPATIONAL EXPOSURE AND RISK ESTIMATES**

## EXPOSURE ESTIMATION

### Methods:

All occupational exposures were estimated using EPA ChemSTEER v3.0 (version: 09/30/2013) using the physical-chemical data published in EPA's Final Risk Evaluation document and using the default model parameters unless otherwise noted. The specific models used and relevant user inputs are described in the subsections that follow.

Chemical Properties - The following chemical properties were used in the assessment:

**Total Assessed Volume (Pv)**: 250 kg/yr
**Vapor Pressure (VPchem)**: 435 torr @ 25 °C
**Molecular Weight (MW)**: 84.93 g/mol
**Density (Dchem):** 1.33 g/cm3 @ 20 °C
**Solubility in Water (WSchem):** 13 g/L @ 25 °C

The Pv = 250 kg/yr was chosen as a worst case and represents up to 50 maintenance activities per year on the system, each of which involves loss of < 1 gallon of methylene chloride. The entire system holds 2700 gallons (13,593 kg) and, in the past 30 years, has only ever had to be completely drained and replaced once, representing only 453 kg/yr.

Operations - Figure 1 shows a representation of the system. As indicated, operation of the system involves limited opportunities for exposure to methylene chloride, otherwise the system is completely closed. The only notable exposures are:

- [A1] transferring new methylene chloride into the charge tank
- [A2] sampling
- [A3] maintenance (e.g. pump seal failure)

Given the above activities, the following operations were assessed:

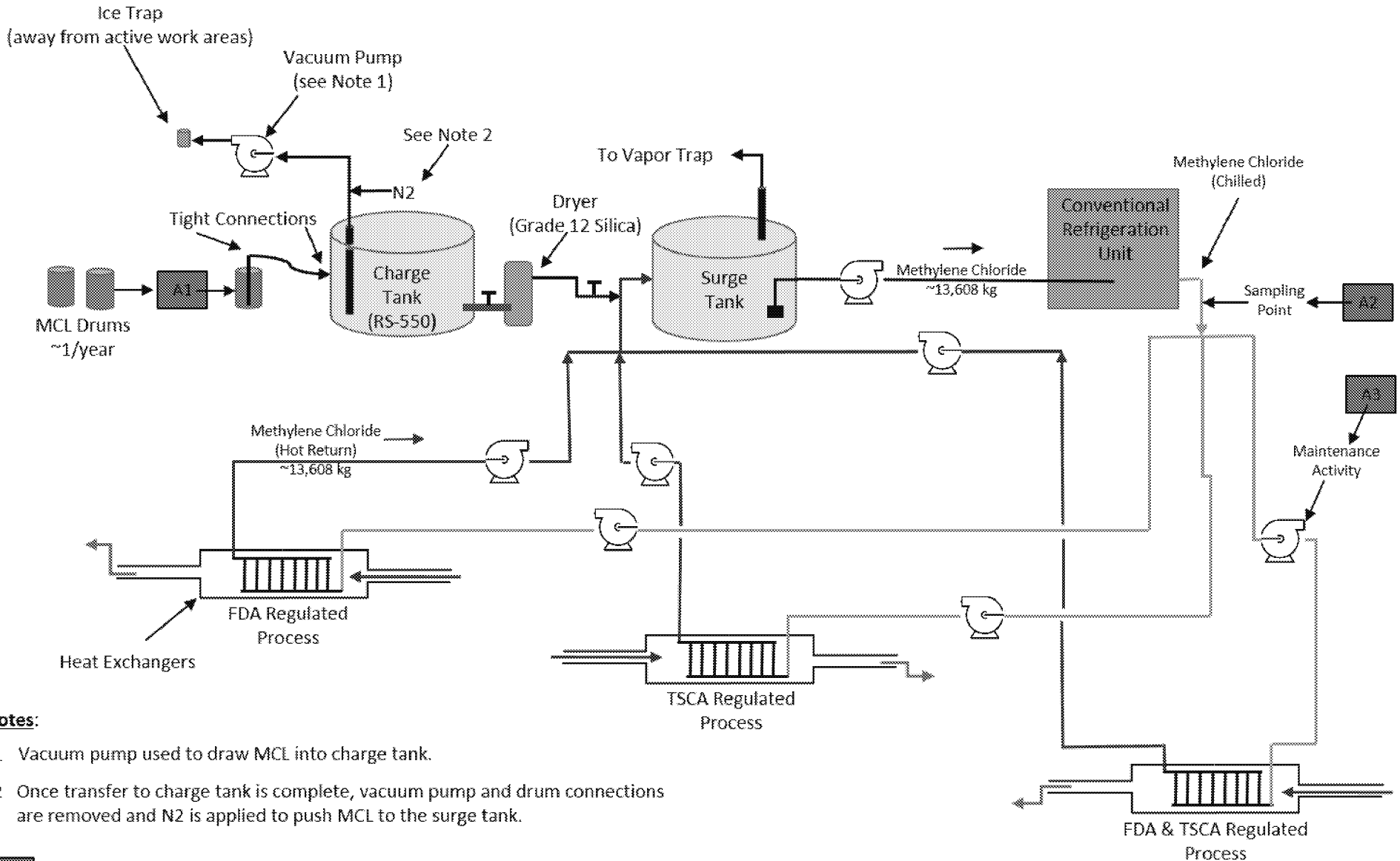
**Unloading Liquid Raw Material from Drums**
**Sampling Liquid Raw Material** [(*)] / [(*)] Includes maintenance (see discussion below)

Cleaning empty drums was not assessed as this activity is not performed at the site and is commonly associated with environmental release rather than worker exposure. Empty drums are sent offsite for recovery and/or disposal. With regards to [A3] maintenance, a typical activity would involve repairing a pump seal failure, in which case the site's written policies state that before a line break is permitted, the pump must first be cleared with nitrogen making sure to discharge the nitrogen and any methylene chloride vapor into the system (not to atmosphere). Then, any residual methylene chloride remaining in the pump/line is drained/collected in a container, similar to a sampling activity. Since these exposures involve maintenance personnel rather than operators who perform the sampling, the exposure assessments for sampling was used to represent a typical and worst-case maintenance activity as well. In other words, there was no need to double the amount of exposure to any individual worker.

Operation Parameters - The following operation parameters were used:

**Type of Operation**: Batch Operation (Using Raw Material)
**Number of Sites (NS)**: 1
**Total batches/site-year (Nby)**: 52
**Weight fraction (Yrm)**: 1

# FIGURE 1 – METHYLENE CHLORIDE (MCL) HEAT TRANSFER FLUID SYSTEM




**Notes**:

1 Vacuum pump used to draw MCL into charge tank.

2 Once transfer to charge tank is complete, vacuum pump and drum connections are removed and N2 is applied to push MCL to the surge tank.

A1 Worker Activity (Unloading Drums, ~ once per week for a total volume of ~1 drum per year to replace MCL lost within the process and, to a lesser extent, to sampling and maintenance).

A2 Worker Activity (Sampling, once per week by operators)

A3 Worker Activity (Maintenance, < once per week by maintenance personnel)

The Nby = 52 was chosen as the maximum number of days per year that a worker would be exposed to methylene chloride either as a result of a weekly sampling activity (operators) or a weekly maintenance activity (maintenance personnel), with the former representing the actual frequency and the latter representing a worst-case estimate of the frequency. This also corresponds to a worst-case frequency for unloading drums of MCL to replace the volume lost due to process leaks that are contained within the process and, to a lesser extent, the volume lost from sampling and maintenance activities.

Models Used & Inputs - The following ChemSTEER models and inputs were used to estimate chemical exposure:

| Activity | Dermal Model(s) | Inhalation Model(s) | Non-Default Inputs |
|---|---|---|---|
| Unloading MCL from Drums | 2-Hand Dermal Contact with Liquid Model | Mass Balance Model | - AT = 31 years (Typical) or 40 years (Worst Case)<br>- ATc = 78 years<br>- BW = 80 kg<br>- EY = 31 years (Typical) or 40 years (Worst Case)<br>- NWexp = 4<br>- G: 0.03847557 g/s [1]<br>- Yderm = 0.08 [2] |
| Sampling MCL | 1-Hand Dermal Contact with Liquid Model | Mass Balance Model | - AT = 31 years (Typical) or 40 years (Worst Case)<br>- ATc = 78 years<br>- BW = 80 kg<br>- EY = 31 years (Typical) or 40 years (Worst Case)<br>- NWexp = 4<br>- G = 0.1383893 g/s [1]<br>- Yderm = 0.08 [2] |

[2] Per EPA/OPPT Mass Transfer Coefficient Model.

[3] Yderm = Weight Fraction (Wf) x Proportion Remaining on Skin (*fabs*) = 1 x 0.08 = 0.08

**Exposure Estimate Results**:

The following exposure estimates where generated from the ChemSTEER model:

**Worker Inhalation Exposure to Methylene Chloride during Unloading Drums**

| | Central Tendency | Worst Case |
|---|---|---|
| **Model Output / Model Result:** | | |
| Potential Dose Rate (mg/day) | $7.2827 \times 10^{-4}$ | $6.5544 \times 10^{-3}$ |
| **Calculated from the Above Model Result / Values Used for MOE Risk Calculations:** | | |
| 8-hr TWA Exposure Concentration ($mg/m^3$) [1] | $7.2827 \times 10^{-5}$ | $6.5544 \times 10^{-4}$ |
| Average Daily Concentration (ADC)($mg/m^3$) [2] | $3.4585 \times 10^{-6}$ | $3.1126 \times 10^{-5}$ |
| Lifetime Average Daily Concentration (LADC) ($mg/m^3$) [3] | $6.0204 \times 10^{-6}$ | $6.9914 \times 10^{-5}$ |

[1] 8-hr TWA ($mg/m^3$) = Potential Dose Rate (mg/day) x $(8\ hrs/day)^{-1}$ x $(1.25\ m^3/hr)^{-1}$, where 1.25 $m^3$/hr is respiration rate.

[2] ADC ($mg/m^3$) = (8-hr TWA ($mg/m^3$) x 8 hr/day x 250 days/yr x WY) ÷ (WY x 365 days/yr x 24 hr/day), where WY=31 or 40.

[3] LADC ($mg/m^3$) = (8-hr TWA ($mg/m^3$) x 8 hr/day x 250 days/yr x WY) ÷ (78 x 250 days/yr x 24 hr/day), where WY=31 or 40.

**Worker Inhalation Exposure to Methylene Chloride during Sampling**

| | Central Tendency | Worst Case |
|---|---|---|
| **Model Output / Model Result:** | | |
| Potential Dose Rate (mg/day) | 3.017 | 27.1534 |
| **Calculated from the Above Model Result / Values Used for MOE Risk Calculations:** | | |
| 8-hr TWA Exposure Concentration ($mg/m^3$) [1] | $3.017 \times 10^{-1}$ | 2.7153 |
| Average Daily Concentration (ADC)($mg/m^3$) [2] | $1.4327 \times 10^{-2}$ | $1.2895 \times 10^{-1}$ |
| Lifetime Average Daily Concentration (LADC) ($mg/m^3$) [3] | $2.4941 \times 10^{-2}$ | $2.8964 \times 10^{-1}$ |

[1] 8-hr TWA ($mg/m^3$) = Potential Dose Rate (mg/day) x (8 hrs/day)$^{-1}$ x (1.25 $m^3$/hr)$^{-1}$, where 1.25 $m^3$/hr is respiration rate.

[2] ADC ($mg/m^3$) = (8-hr TWA ($mg/m^3$) x 8 hr/day x 250 days/yr x WY) ÷ (WY x 365 days/yr x 24 hr/day), where WY=31 or 40.

[3] LADC ($mg/m^3$) = (8-hr TWA ($mg/m^3$) x 8 hr/day x 250 days/yr x WY) ÷ (78 x 250 days/yr x 24 hr/day), where WY=31 or 40.

**Worker Dermal Exposure to Methylene Chloride during Unloading Drums**

| | Central Tendency | Worst Case |
|---|---|---|
| **Model Output / Model Results:** | | |
| Acute Potential Dose (mg/kg-day) | 0.749 | 2.247 |
| Average Daily Dose (mg/kg-day) | 0.1067 | 0.3201 |
| Lifetime Average Daily Dose (mg/kg-day) | 0.042 | 0.1642 |

**Worker Dermal Exposure to Methylene Chloride during Sampling**

| | Central Tendency | Worst Case |
|---|---|---|
| **Model Output / Model Results:** | | |
| Potential Dose Rate (mg/kg-day) | 0.3745 | 1.1235 |
| Average Daily Dose (mg/kg-day) | 0.053 | 0.1601 |
| Lifetime Average Daily Dose (mg/kg-day) | 0.021 | 0.082 |

**RISK CHARACTERIZATION**

Given the exposure estimates above and using EPA's risk characterization methodology, the relevant MOEs and cancer risks are calculated as follows:

**Risk Estimate for Acute, Non-Cancer Inhalation Exposures**

| HEC Time Period Endpoint = CNS Effects | Acute HEC ($mg/m^3$) | Exposure Level | MOEs for Acute Exposures | | | Benchmark MOE |
|---|---|---|---|---|---|---|
| | | | No Respirator | APF 25 | APF 50 | |
| 8-hr (Drum Unloading) | 290 | High-End | $4.4245 \times 10^5$ | N/A | N/A | 30 |
| | | Central Tendency | $3.9820 \times 10^6$ | N/A | N/A | |
| 8-hr (Sampling) | 290 | High-End | $1.0680 \times 10^2$ | N/A | N/A | 30 |
| | | Central Tendency | $9.6122 \times 10^2$ | N/A | N/A | |

**Risk Estimate for Chronic, Non-Cancer Inhalation Exposures**

| Endpoint (Activity) | Chronic HEC ($mg/m^3$) | Exposure Level | MOEs for Acute Exposures | | | Benchmark MOE |
|---|---|---|---|---|---|---|
| | | | No Respirator | APF 25 | APF 50 | |
| Liver Effects (Drum Unloading) | 17.2 | High-End | $5.5259 \times 10^5$ | N/A | N/A | 10 |
| | | Central Tendency | $4.9733 \times 10^6$ | N/A | N/A | |

| Endpoint (Activity) | Chronic HEC ($mg/m^3$) | Exposure Level | MOEs for Acute Exposures | | | Benchmark MOE |
|---|---|---|---|---|---|---|
| | | | No Respirator | APF 25 | APF 50 | |
| Liver Effects (Sampling) | 17.2 | High-End | $1.3339 \times 10^2$ | N/A | N/A | 10 |
| | | Central Tendency | $1.2005 \times 10^3$ | N/A | N/A | |

**Risk Estimate for Chronic, Cancer Inhalation Exposures**

| Endpoint (Activity) | IUR (risk per $mg/m^3$) | Exposure Level | MOEs for Acute Exposures | | | Benchmark MOE |
|---|---|---|---|---|---|---|
| | | | No Respirator | APF 25 | APF 50 | |
| Cancer Risk (Drum Unloading) | $1.38 \times 10^{-6}$ | High-End | $10^{-11}$ | N/A | N/A | $10^{-4}$ |
| | | Central Tendency | $10^{-12}$ | N/A | N/A | |
| Cancer Risk (Sampling) | $1.38 \times 10^{-6}$ | High-End | $10^{-7}$ | N/A | N/A | $10^{-4}$ |
| | | Central Tendency | $10^{-8}$ | N/A | N/A | |

**MOEs for Acute Dermal Exposure for CNS Effects POD = 16 mg/kg/day, Benchmark MOE=30**

| Activity | Exposure Level | MOEs with Glove PFs | | | |
|---|---|---|---|---|---|
| | | No Gloves | PF 5 | PF 10 | PF 20 |
| Unloading Drums | High-End | **7.12** | 35 | N/A | N/A |
| | Central Tendency | **21.4** | 107 | N/A | N/A |
| Sampling | High-End | **14.24** | 71.2 | N/A | N/A |
| | Central Tendency | 42.7 | N/A | N/A | N/A |

**MOEs for Chronic Dermal Exposure for Liver Effects POD = 2.15 mg/kg/day, Benchmark MOE=10**

| Activity | Exposure Level | MOEs with Glove PFs | | | |
|---|---|---|---|---|---|
| | | No Gloves | PF 5 | PF 10 | PF 20 |
| Unloading Drums | High-End | **6.7** | 33.5 | N/A | N/A |
| | Central Tendency | **20.1** | 100 | N/A | N/A |
| Sampling | High-End | **13.4** | 67 | N/A | N/A |
| | Central Tendency | 40.6 | N/A | N/A | N/A |

**Cancer Risk for Chronic Dermal Exposure CSF = 1.1 x $10^{-5}$ per mg/kg/day**

| Activity | Exposure Level | MOEs with Glove PFs | | | |
|---|---|---|---|---|---|
| | | No Gloves | PF 5 | PF 10 | PF 20 |
| Unloading Drums | High-End | $10^{-6}$ | N/A | N/A | N/A |
| | Central Tendency | $10^{-7}$ | N/A | N/A | N/A |
| Sampling | High-End | $10^{-7}$ | N/A | N/A | N/A |
| | Central Tendency | $10^{-7}$ | N/A | N/A | N/A |

## SUMMARY AND CONCLUSIONS

Given the conservative exposure and risk estimates outlined above, using EPA methodology, all MOEs exceed the applicable target MOEs and all cancer risks are less than $10^{-4}$, with and without regards to the use of respiratory protection. Regarding dermal exposures, exposure estimates suggest a potential for significant acute and chronic exposure, for non-cancer effects only, without the use of gloves during drum unloading and sampling activities. However, the assessment further shows that dermal exposure can be adequately controlled by the use of even the least protective gloves when direct contact to methylene chloride is possible.